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STANDARDIZATION OF SPACING AND FERTILIZERS IN SONG OF INDIA *(Dracaena reflexa* Lam.) UNDER SHADE HOUSE CONDITION

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ABSTRACT

An experiment entitled "Standardization of spacing and fertilizers in Song of India *(Dracaena reflexa* Lam.) under shade house condition" was conducted during 2024-2025 at Horticulture Research and Extension Centre, Kanabargi, Belagavi, Karnataka, using a Split Plot Design with nine treatments replicated thrice. The study evaluated three spacings, S_1 (0.45 m × 0.30 m), S_2 (0.45 m × 0.45 m), S_3 (0.60 m × 0.45 m) and three fertilizer doses, F_1 (50:25:25 g NPK/plant/year), F_2 (75:37:37 g NPK/plant/year), F_3 (100:50:50 g NPK/plant/year), applied at bi-monthly intervals. Spacing S_1 (0.45 m × 0.30 m) recorded the highest plant height (70.95 cm), number of primary branches and secondary branches (3.08 and 3.48 respectively), leaf area (828.57 cm^2), number of cut shoots per plant (9.00), fresh weight of cut shoots per plant (440.59 g), shelf life (5.78 days), vase life (37.96 days), chlorophyll content (57.90 SPAD value) and maximum B:C ratio (2.20). Among the fertilizer levels, F_2 (75:37:37 g NPK/plant/year) produced the tallest plants (69.25 cm), number of primary and secondary branches (3.00 and 3.40 respectively), leaf area (789.77 cm^2), number of cut shoots per plant (8.67), fresh weight of cut shoot per plant (388.87 g), shelf life (5.45 days), vase life (36.28 days) and chlorophyll content (51.54 SPAD value) with a B:C ratio of 1.87. The interaction S_1F_2 (0.45 m × 0.30 m with 75:37:37 g NPK/plant/year) resulted in the maximum plant height (72.76 cm), number of primary branches and secondary branches (3.20 and 3.74 respectively), leaf area (851.36 cm^2), number of cut shoots/plant (10.00), fresh weight of cut shoots/plant (525.00 g), shelf life (6.03 days), vase life (39.42 days), chlorophyll content (63.44 SPAD value) and the same combination also recorded the highest B:C ratio (2.45), indicating its superiority for growth, yield and economic return of *Dracaena reflexa* under shade house conditions.

***Keywords* :** *Dracaena reflexa*, Song of India, Spacing, Fertilizer, Shadehouse

Introduction

"Cut foliage" or "Cut greens" is widely used in the floral industry to enhance bouquets and decorative arrangements. The economic value of cut foliage has grown significantly, with its use in bouquets increasing from 5% to 20–25%, particularly during festivals and events (Singh *et al*., 2017). Common varieties include *Dracaena*, *Asparagus*, *Ruscus hypophyllum*, *Codiaeum variegatum*, *Aspidistra elatior*, *Hedera helix*, *Cyperus* and various wild grasses. Among these, *Dracaena* stands out as a key cut foliage plant for both landscaping and indoor use.

Dracaena is widely used in bouquets, floral arrangements and ornamental gardening, including as indoor, edge and potted plants. Notable species include *D. reflexa* (Song of India), *D. deremensis*, *D. fragrans*, *D. godseffiana*, *D. marginata*, and *D. sanderiana*

(Athulya & Singh, 2021). Among them, *D. reflexa* 'Song of India', belongs to the Asparagaceae family, is a high-demand cut foliage plant in both domestic and international markets. Native to tropical and subtropical regions of the Indian Ocean islands, it has a slow-growing, upright, evergreen habit with multiple stems and fragrant white flowers in mid-winter (Bhatia, 2019). Its striking foliage, low maintenance and tolerance to low light make it a popular houseplant. Cultivation under shade to semi-shade conditions mimics its natural understory habitat (Jaminson, 2012).

A shade house, also called a net house, is a framed structure covered with shade or agro nets that regulate sunlight, moisture and air to create a favorable microclimate for plant growth. Shade house cultivation of Dracaena simulates its tropical habitat, with studies showing that 75% shade promotes optimal growth and quality (Srikrishnah *et al*., 2015). Dracaena, known for its air-purifying ability, effectively removes formaldehyde, xylene and trichloroethylene (Wolverton, 1996). It is also profitable for intercropping with rubber, cocoa and coffee, with successful large-scale cultivation in Kerala, Karnataka and Kolkata (Athulya & Singh, 2021).

The successful commercial cultivation of any crop depends on many factors like climate, soil fertility, fertilization, season of growing, spacing etc. Crop-specific management is essential because different crops have varying nutrient requirements and optimal plant densities. Spacing plays a role in manipulating the micro climate and hence helps in enhancing the yield and quality of crop. Proper spacing improves the availability of nutrients, aeration and light intensity which means better crop growth and response to the inputs and there by enhanced the growth, yield and quality of crop (Ravindran *et al*., 1986). As most soils are found to be deficient in essential nutrients required for optimal plant development, the application of fertilizers containing key elements such as nitrogen, phosphorus and potassium is considered necessary. Sustained improvement in productivity can be achieved through the application of balanced nutrient inputs, along with the regular incorporation of soil-based and natural resources. The physiological functions of plants are significantly influenced by the presence of nitrogen, phosphorus and potassium (NPK).

Optimizing plant population and nutrient availability is crucial for maximizing productivity and extending plant lifespan. Proper fertilization improves foliage yield, quality and vase life (Noggle and Fritz, 1979). However, plant requirements vary with location, cultivar, soil fertility, management and cost. Despite this, the combined effects of spacing and fertilization on *Dracaena reflexa* remain unexplored. It is hypothesized that varying plant densities could enhance foliage yield. Thus, an experiment was conducted to assess the impact of plant spacing and nutrient application on *Dracaena reflexa* (Song of India) under shade house conditions.

Material and Methods

A field experiment was conducted during 2024 - 2025 at the Horticulture Research and Extension Centre, Kanabargi, Belagavi, Karnataka, India, using a 6-month-old *Dracaena reflexa* plot. The study included three spacing levels (S_1: 0.45 × 0.30 m, S_2: 0.45 × 0.45 m and S_3: 0.60 × 0.45 m) and three fertilizer levels (F_1: 50:25:25, F_2: 75:37:37 and F_3: 100:50:50 g NPK per plant per year), forming nine treatment combinations. These were arranged in a split plot design with three replications. Nitrogen, phosphorus and potassium were supplied through urea, diammonium phosphate and muriate of potash, respectively. They applied in four equal splits at two-month intervals (September, November, January and March). All other cultural practices were carried out according to standard recommendations.

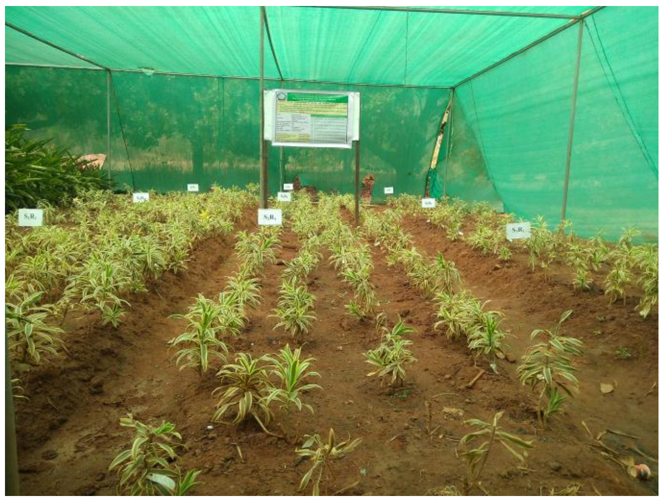

Plate 1: General view of the Experimental site

From each treatment, five plants were randomly selected to record various growth and yield parameters, including yield per plant, per square meter and per 1000 square meters, along with foliage weight. Leaf harvesting was carried out every 45 days throughout the study period and cumulative yield was determined accordingly. To assess soil nutrient status (N, P_2O_5 and K_2O), initial samples were collected from a depth of 15-30 cm in a zigzag pattern across the field before treatment application. Final soil samples were collected separately from each treatment plot after completion of the experiment. The benefit-cost ratio was computed using standard procedures. Nutrient analysis was conducted using the Micro-Kjeldahl method for nitrogen, the Vanadomolybdate method for phosphorus and a flame photometer for potassium.

Results and Discussion

Table 1 : Effect of different spacings and fertilizer levels on growth parameters of Song of India (*Dracaena reflexa*)

Treatments	Plant height (cm)	Number of primary branches	Number of secondary branches	Leaflet length (cm)	Leaflet width (cm)	Internodal length (mm)	Leaf area (cm^2)
Main plot –Spacing							
S_1	70.95	3.08	3.48	16.52	4.19	6.43	828.57
S_2	67.66	3.00	3.30	15.89	3.94	6.57	774.44
S_3	65.00	2.63	2.83	15.18	3.52	7.07	617.67
S.Em±	**0.37**	**0.02**	**0.03**	**0.15**	**0.04**	**0.06**	**8.98**
C.D. (5%)	**1.47**	**0.07**	**0.12**	**0.45**	**0.17**	**0.23**	**35.25**
Subplot - Fertilizer							
F_1	66.33	2.77	3.03	15.65	3.55	7.20	696.45
F_2	69.25	3.00	3.40	16.09	4.20	6.27	789.77
F_3	68.03	2.94	3.18	15.86	3.89	6.60	734.46
S.Em±	**0.71**	**0.03**	**0.03**	**0.13**	**0.04**	**0.07**	**4.95**
C.D. (5%)	**2.19**	**0.09**	**0.10**	**NS**	**0.123**	**0.22**	**15.25**
Interaction (S × F)							
S_1F_1	68.98	2.95	3.11	16.42	3.69	7.29	789.69
S_1F_2	72.76	3.20	3.74	16.61	4.54	5.90	851.36
S_1F_3	71.10	3.08	3.60	16.53	4.34	6.10	844.65
S_2F_1	66.00	2.84	3.29	15.61	3.61	7.00	725.36
S_2F_2	68.99	3.07	3.46	16.25	4.32	6.00	838.27
S_2F_3	68.00	3.08	3.15	15.82	3.88	6.70	759.68
S_3F_1	64.00	2.51	2.70	14.91	3.34	7.30	574.29
S_3F_2	66.00	2.72	2.99	15.42	3.75	6.90	679.68
S_3F_3	65.00	2.66	2.80	15.22	3.46	7.00	599.05
S.Em±	**1.23**	**0.05**	**0.05**	**0.22**	**0.07**	**0.12**	**8.57**
C.D. (5%)	**3.79**	**0.15**	**0.17**	**0.70**	**0.22**	**0.37**	**26.41**

The different plant spacing showed significant effect on growth parameters (Table 1). The maximum plant height (70.95 cm), number of primary branches (3.08), number of secondary branches (3.48), leaflet length (16.52 cm), leaflet width (4.19 cm) and leaf area (828.57 cm^2) was recorded in spacing of S_1 (0.45 × 0.30 m), which was followed by S_2 (0.45× 0.45 m) and minimum in S_3 (0.60 × 0.45 m) at 240 DAT. Closer spacing increased plant height in Dracaena due to intensified light competition and the shadowing effect, which promoted vertical elongation, consistent with findings by Sumangala *et al*. (2013), Manimaran and Ganga (2022), Ansar *et al*. (2014), Pratibha *et al*. (2018) and Dorajeerao *et al*. (2012). Unlike most crops, closer spacing which is optimum for this crop, produced more branches, likely due to a reduced red to far red ratio that stimulated axillary bud growth and Dracaena's natural tendency for lateral shoot formation under crowding, as also reported by Singh *et al*. (2015) and Kumar (2017). The favorable microclimate under dense planting, with higher humidity and diffused light, promoted leaf expansion and leaflet development in agreement with Niinemets (2010) and Shimizu-Sato and Mori (2001). Internodal length was greatest at wider spacing (S_3: 0.60 × 0.45 m) and shortest at closer spacing, as higher density and fertilizer levels limited light interception and photosynthetic efficiency. These results align with Singh *et al*. (2014) and Taiz and Zeiger (2010), who noted that plant crowding restricts growth through increased competition and reduced light availability.

Fertilizer application significantly influenced gowth parameters of Song of India throughout all stages of crop growth (Table 1). At 240 DAT the highest plant height (69.25 cm), number of primary branches (3.00), number of secondary branches (3.40), leaflet length (16.09cm), leaflet width (4.20 cm) and leaf area (789.77cm^2) were observed with treatment F_2 (75:37:37 g NPK/plant/year), which was followed by F_3 (100:25:25 g NPK/plant/year) and the lowest heights were recorded under treatment F_1 (50:25:25 g NPK/plant/year). Whereas intermodal length was higher in F_1, followed by F_3 and least in F_2. Enhanced plant height, branching, leaflet size and leaf area in F_2 was due to better nutrient availability, especially nitrogen, which promoted root, stem and leaf development (Shoram *et al*., 2012; Chamakumari *et al*., 2017; Mangroliya *et al*., 2021). Increased NPK stimulated vegetative growth and branching (Ozukum *et al*., 2022; Bilji *et al*., 2022; Qasim *et al*., 2008). Nitrogen improved cell division, chlorophyll synthesis and cytokinin activity, resulting in larger leaves (Mengel & Kirkby, 2012; Cline, 1997; Singh *et al*., 2015; Kumar *et al*., 2017). Similar effects were observed in rose, tuberose, hibiscus, lilies, and curry leaf (Bhattacharjee & Mukherjee, 1983; Rathore & Singh, 2013; Sa'id *et al*., 2015; Hebbale *et al*., 2021; Jagadeeshkanth, 2014). Conversely, higher fertilizer doses resulted in shorter internodes due to increased nitrogen availability, which tends to encourage dense, vegetative growth by stimulating leaf and shoot production rather than stem elongation (Marschner, 2012) and reduced fertilizer caused longer internodes due to limited nutrients and compensatory elongation (Marschner, 2012; Salisbury & Ross, 1992; Kumar *et al*., 2016).

Table 2 : Effect of different spacings and fertilizer levels on yield, quality and biochemical characters of Song of India (*Dracaena reflexa*)

Treatments	Number of days between two harvest	Number of cut shoots per plant	Number of cut shoots per m^2	Fresh weight of cut shoots per plant (g)	Fresh weight of cut shoots per m^2 (kg)	Shelf life (days)	Vase life (days)	Chlorophyll content (µmol per m^2)
Main plot - Spacing								
S_1	42.33	9.00	55.53	440.59	2.71	5.78	37.96	57.90
S_2	47.33	8.00	39.20	317.16	1.55	5.17	35.44	46.31
S_3	52.00	6.00	22.20	194.15	0.72	4.59	32.20	41.38
S.Em±	**0.69**	**0.089**	**0.47**	**2.42**	**0.01**	**0.04**	**0.27**	**0.29**
C.D. (5%)	**2.73**	**0.350**	**1.84**	**9.52**	**0.05**	**0.16**	**1.05**	**1.15**
Subplot - Fertilizer								
F_1	50.00	6.67	34.05	248.32	1.31	4.95	33.90	47.61
F_2	44.67	8.67	43.90	388.87	2.02	5.45	36.28	51.54
F_3	47.00	7.67	38.98	314.71	1.65	5.13	35.41	46.44
S.Em±	**0.39**	**0.04**	**0.25**	**2.77**	**0.02**	**0.04**	**0.27**	**0.396**
C.D. (5%)	**1.193**	**0.14**	**0.78**	**8.55**	**0.06**	**0.12**	**0.83**	**1.220**
Interaction (S × F)								
S_1F_1	45.00	8.00	49.36	353.52	2.18	5.50	36.24	56.43
S_1F_2	40.00	10.00	61.70	525.00	3.23	6.03	39.42	63.44
S_1F_3	42.00	9.00	55.53	443.25	2.73	5.80	38.21	53.83
S_2F_1	50.00	7.00	34.30	244.93	1.20	5.00	34.96	46.12
S_2F_2	45.00	9.00	44.10	393.12	1.92	5.40	36.12	49.01
S_2F_3	47.00	8.00	39.20	313.44	1.53	5.10	35.23	43.79
S_3F_1	55.00	5.00	18.50	146.50	0.54	4.35	30.50	40.27
S_3F_2	49.00	7.00	25.90	248.50	0.92	4.91	33.30	42.17
S_3F_3	52.00	6.00	22.20	187.44	0.69	4.50	32.80	41.71
S.Em±	**0.67**	**0.08**	**0.44**	**4.80**	**0.03**	**0.07**	**0.47**	**0.68**
C.D. (5%)	**2.06**	**0.25**	**1.36**	**14.80**	**0.10**	**0.21**	**1.44**	**2.11**

The interaction between plant spacing and nutrient levels had a significant impact on plant growth parameters throughout the study (Table 1). At 240 DAT, the combination of the optimum spacing and the high nutrient dose S_1F_2 (0.45 × 0.30 m with 75:37:37 g NPK/plant/year) resulted in the tallest plant (72.76cm), number of primary branches (3.20), number of secondary branches (3.74), leaflet length (16.61 cm), leaflet width (4.54 cm) and leaf area (851.36 cm^2) which was followed by S_1F_3 and the lowest heights were recorded under S_3F_1 due to improved nutrient use and favorable microclimate under dense planting

(Divyashree, 2016; Manjula *et al*., 2023). Enhanced cytokinin synthesis and reduced apical dominance promoted lateral branching and leaf expansion (Singh *et al*., 2015; Kumar, 2017). Similar synergistic effects of dense spacing and optimal fertilization were reported in Asparagus and Cordyline (Pathak, 2013; Patel, 2018). Whereas intermodal length was higher in S_3F_1 and the shortest internodes (5.90 cm) in S_1F_2 indicated compact growth, desirable for ornamentals. Comparable trends were observed in Chlorophytum and Dieffenbachia (Kumar *et al*., 2016).

Significant variations in the yield parameters were observed at different spacing levels (Table 2). Notably, the spacing S_1 (0.45 m × 0.30 m) recorded the less number of days between the two harvest means more yield *i.e*., 42.33 days, highest number of cut shoots per plant (9.00), number of cut shoots per m^2 (55.53), fresh weight of cut shoots per plant (440.59 g), fresh weight of cut shoots per m^2 (2.71 kg), shelf life (5.78 days), vase life (37.96 days) and Chlorophyll content (57.90 µmol per m^2) followed by S_2 (0.45 m × 0.45 m) and the lowest was recorded under the spacing S_3 (0.60 × 0.45 m). Cut shoots are the valuable part of Song of India used widely in floral decorations, and their yield was primarily influenced by plant spacing. The increased number of cut shoots was linked to a higher count of primary and secondary branches, showing that optimum spacing enhances productivity, similar to findings in rose and nerium by Sujatha and Singh (2003), Viradia and Singh (2004), Bhattacharjee (1992), Bhattacharya *et al*. (2001) and Manjula (2021). The highest fresh weight of cut shoots per plant (440.59 g) and per m² (2.71 kg) was also recorded in S_1 due to greater plant density, consistent with studies by Marino *et al*. (2003), Ilodibial *et al*. (2016) and Lalhruaitluangi (2022). Shelf life (5.78 days) and vase life (37.96 days) were longest in S_1, likely due to better air circulation, light and nutrient use, agreeing with patterns reported for leather leaf fern by Mathur *et al*. (1982), Poole *et al*. (1985), and Stamps *et al*. (1989). The maximum chlorophyll content (57.90) observed in S_1 may be due to optimal nutrient, sunlight and aeration utilization, as also reported by Hussein *et al*. (2006) in *Dracocephalum moldavica* and Abebe (2007) in Vernonia.

The application of different doses of fertilizer led to significant variations in the yield parameters of Song of India. (Table 2). Application of F_2 (75:37.5:37.5 g NPK / plant /year) was recorded the less number of days between the two harvest means more yield *i.e*., 44.67 days, highest number of cut shoots per plant (8.67), number of cut shoots per m^2 (43.90), fresh weight of cut shoots per plant (388.87 g), fresh weight of cut shoots per m^2 (2.02 kg), shelf life (5.45 days), vase life (36.28 days) and chlorophyll content (51.54 µmol per m^2) followed closely by F_3 (100:50:50 g NPK/ plant / year. The lowest was observed in treatment F_1 (50:25:25 g NPK / plant /year). Improved yields in F_2 were attributed to optimal NPK levels that enhanced nutrient uptake and photosynthesis, aligning with findings by Waseem and Nadeem (2000) in rose, Karetha *et al*. (2011) in gaillardia, Shilpa *et al*. (2011) in golden rod and Jagadeeshkanth (2014) in curry leaf. Fresh weight of cut shoots was also highest in F_2 due to improved nutrient availability and growth efficiency, confirming similar observations in the same studies. Shelf life and vase life were maximized under F_2, likely because adequate nutrients ensured sufficient stored food and potassium reduced transpiration, consistent with findings by Shilpa *et al*. (2011), Naggar (2009) and Pal and Ghosh (2010). The maximum chlorophyll content (51.54) in F_2 was due to enhanced nitrogen uptake, increasing chlorophyll synthesis and photosynthetic efficiency. These results agree with reports by Waseem and Nadeem (2000) in rose, Sharma *et al*. (2009), El-Sayed *et al*. (2016) in cycas, and Jagadeeshkanth (2014) in curry leaf.

Combining various spacing and fertilizer doses had a significant impact on the yield parametes of the plant (Table 2). The less number of days between the two harvest means more yield *i.e*., 40.00 days, highest number of cut shoots per plant (10.00), number of cut shoots per m^2 (61.70), fresh weight of cut shoots per plant (525.00 g), fresh weight of cut shoots per m^2 (3.23 kg), shelf life (6.03 days), vase life (39.42 days) and chlorophyll content (63.44 µmol per m^2) was recorded under the treatment combination S_1F_2 (Spacing 0.45 m × 0.30 m with 75:37.5:37.5 g NPK per plant per year), followed by S_1F_3 and S_2F_2. This treatment improved morphological traits such as plant height, branching, spread and stem girth due to adequate nutrient supply enhancing photosynthesis, consistent with findings in Nerium (Manjula, 2021), Heliconia (Patil *et al*., 2022), Strawflower (Badawy *et al*., 2011), Curry leaf (Jagadeeshkanth, 2014), Crossandra (Priyanka, 2015), Celosia (Ilodibial *et al*., 2016) and Rose (Singh and Dadlani, 1988; Sujatha and Singh, 2003). The highest fresh weights were also recorded in S_1F_2 due to higher plant density and better nutrient availability, as similarly reported in the above studies. Maximum shelf life (6.03 days) and vase life (39.42 days) were observed in S_1F_2, attributed to optimal plant density and sufficient nutrient reserves in harvested shoots. These results agree with the findings of Grassotti *et al*. (2002) and Lalhruaitluangi (2022) in Asparagus and Shilpa *et al*. (2011) in Golden rod.

Effect of different spacings and fertilizer levels on available soil nutrient status (N, P_2O_5 and K_2O) of Song of India (*Dracaena reflexa*) initial and end of the experiment

Table 3: Initial available nutrient status of soil (before treatment imposition)

Sl. No.	Particulars	Values
1.	Available nitrogen (N, kg/ha)	258.00
2.	Available phosphorus (P_2O_5, kg/ha)	5.78
3.	Available potassium (K_2O, kg/ha)	170

Available nitrogen was significantly influenced by both factors. S_3 (0.60 m x 0.45 m) had the highest N content (233.28 kg/ha) and S_1 (0.45 x 0.30) the lowest (166.16 kg/ha). Fertilizer F_1 (50:25:25 g NPK/plant) contributed to the highest N availability (203.11 kg/ha), followed by F_3 (100:50:50 g NPK/plant) and F_2 (75:37:37 g NPK/plant) *i.e.*, 193.38 kg/ha and 182.01kg/ha respectively as shown in Table 4. The interaction S_3F_1 recorded the highest nitrogen content (241.24 kg/ha), which might be due to better nutrient uptake, nutrient use efficiency and mineralization at optimal spacing with recommended fertilization. According to Sharma and Verma (2021)**,** nitrogen availability is enhanced in wider spacings due to reduced root competition and better microbial nitrification.

Table 4 : Effect of various spacing, fertilizer and interaction of spacing and fertilizer on soil nutrient status (N, P_2O_5 and K_2O) of Song of India (*Dracaena reflexa*) at end of the experiment

Treatments	N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)
Main plot - Spacing			
S_1	166.16	3.67	112.37
S_2	179.06	4.62	145.50
S_3	233.28	5.36	162.48
S.Em±	**2.15**	**0.04**	**1.35**
C.D. (5 %)	**8.46**	**0.17**	**5.31**
Sub plot- Fertilizer			
F_1	203.11	4.83	142.54
F_2	182.01	4.29	135.01
F_3	193.38	4.53	142.80
S.Em±	**1.23**	**0.04**	**0.92**
C.D. (5 %)	**3.80**	**0.13**	**2.83**
Interaction (S X F)			
S_1F_1	175.61	4.01	104.53
S_1F_2	158.65	3.36	112.25
S_1F_3	164.21	3.64	120.34
S_2F_1	192.48	4.86	154.89
S_2F_2	165.03	4.34	135.24
S_2F_3	179.67	4.65	146.38
S_3F_1	241.24	5.61	168.21
S_3F_2	222.36	5.18	157.54
S_3F_3	236.25	5.29	161.68
S.Em±	**2.14**	**0.07**	**1.59**
C.D. (5 %)	**6.59**	**0.23**	**4.91**

Phosphorus availability followed a similar trend in Table 4, increasing significantly under S_3 (0.60 x 0.45) that is 5.36 kg/ha and highest in F_1 (4.83 kg/ha), with the S_3F_1 interaction yielding 5.61 kg/ha. P is critical for root development and cell division, especially in young foliage. Hence more number of plants likely uptake more P. In cut foliage species like Monstera and Philodendron**,** higher phosphorus levels improve root establishment and indirectly enhance leaf size and longevity, as reported by Meena *et al.* (2020).

Potassium levels were notably improved under wider spacing S_3 (0.60 x 0.45) that is 162.48 kg/ha and fertilization F_3 (50:25:25 g NPK/ plant) - 142.54 kg/ha. The interaction S_3F_1 yielded the highest potassium content (168.21 kg/ha) as shown in the Table 4, suggesting cumulative benefits of reduced competition and proper nutrient application. Higher plant density depletes soil K due to intensive uptake, while balanced fertilization replenishes it. Potassium vital for leaf rigidity, color enhancement and resistance to mechanical damage. The importance of potassium in foliage quality maintenance, particularly in long-lasting species like Ruscus and Aralia, has been emphasized by Singh *et al*. (2021), who noted improved shelf life and foliage crispness under higher K availability.

Table 5 : Economics of cultivation Song of India (*Dracaena reflexa*) crop as influenced by different spacing and fertilizers levels

Treatment	Cost of cultivation	Gross return	Net return	B:Cratio
Main plot – Spacing				
S_1	226711.83	500112.00	273400.17	2.20
S_2	176297.30	296320.00	120022.70	1.67
S_3	151111.92	185226.67	34114.74	1.22
Subplot – Fertilizer				
F_1	175216.83	290176.00	114959.17	1.59
F_2	184494.60	361176.00	176681.40	1.87
F_3	194409.63	330306.67	135897.04	1.63
Interaction (S × F)				
S_1F_1	213570.99	444544.00	230973.01	2.08
S_1F_2	226417.74	555680.00	329262.26	2.45
S_1F_3	240146.77	500112.00	259965.23	2.08
S_2F_1	167537.99	259280.00	91742.01	1.54
S_2F_2	176101.20	333360.00	157258.80	1.89
S_2F_3	185252.71	296320.00	111067.29	1.59
S_3F_1	144541.51	166704.00	22162.49	1.15
S_3F_2	150964.86	194488.00	43523.14	1.28
S_3F_3	157829.40	194488.00	36658.60	1.23

The ultimate factor for assessing the most suitable treatment options is their economic feasibility. The data in Table 5, indicated that plant spacing of 0.45 m × 0.30 m (S_1) resulted in a higher cost of cultivation (Rs. 226711.83 per 1000 m^2). It was due to the higher rates of plants required for the cultivation of Song of India at S_1 compared to S_2 and S_3. Higher gross returns (Rs. 500112.00 1000 m^2), net returns (Rs. 273400.17 1000 m^2) and benefit cost ratio (2.20) are recorded at plant spacing of 0.45 m x 0.30 m (S_1). Higher gross returns and net returns were due to higher number of cut shoots yield. This may be attributed to optimum plant density, good growth and yield performance of plants. These results are in conformity with the findings by Rao (2005) in cut flowers and in Nerium by Manjula (2021).

The combination of well-balanced nutrient supply achieved through the use of fertilizers and farmyard manure (FYM) has extended the availability of essential nutrients for the Song of India crop, resulting in improved growth and yield parameters. This in turn has led to the highest yield observed in the F_2 ultimately in getting a higher gross return Rs. 361176.00 1000 m^2 and net return Rs. 176681.40 1000 m^2 compared to other levels of fertilizer. However, B:C ratio was highest in F_2 (1.87). Lower gross returns, net returns and B:C ratio might be the lesser cost of input used in executing F_1 treatment. Among interaction of spacing and fertilizer, the interaction of S_1F_2 resulted in higher gross returns (Rs. 555680.00 for 1000 m^2), net returns (Rs. 329262.26 for 1000 m^2) and B:C ratio (2.45) in Table 5. Higher net returns and B:C ratio was due to the optimum utilization of nitrogen, phosphorus and potassium coupled with optimum spacing lead to production of higher cut shoot yield attributed to the interaction of S_1F_2. These results are in conformity with the findings of Singh *et al*. (2018) in gladiolus cv. Candyman, Balagamsetty *et al*. (2018) in Oncidium orchid.

Conclusion

In the experimental study, it was finally concluded that the combination of optimum spacing S_1 (0.45 x 0.30 m) with 75:37:37g NPK/plant/year (F_2) was identified as beneficial for achieving a superior quality in growth parameters, yield parameters, quality parameters, biochemical parameter and soil nutrient parameters. The treatment combination of S_1F_2 (0.45 x 0.30 m, 75:37:37 g NPK/plant/year) recorded the maximum yield per plant and per m^2 with the highest gross returns, net returns and benefit-cost ratio, which was followed by the S_1F_3 treatment combination in Song of India.

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